DIURNAL VARIATIONS OF PRECIPITATION AT HONOLULU, HAWAII

551.578.1 (969)

By ELMER H. LOVERIDGE

[U. S. Weather Bureau, Honolulu]

Despite the fact that the greater portion of the rainfall of the Hawaiian Islands is caused by the ascent of the northeast trade winds over the mountains, there are large areas where this type of rain rarely occurs. Such areas are the lowlands a considerable distance to the leeward of the mountains. They show a marked minimum of rainfall in the summer months and early autumn, and a maximum in the winter and early spring for Oahu

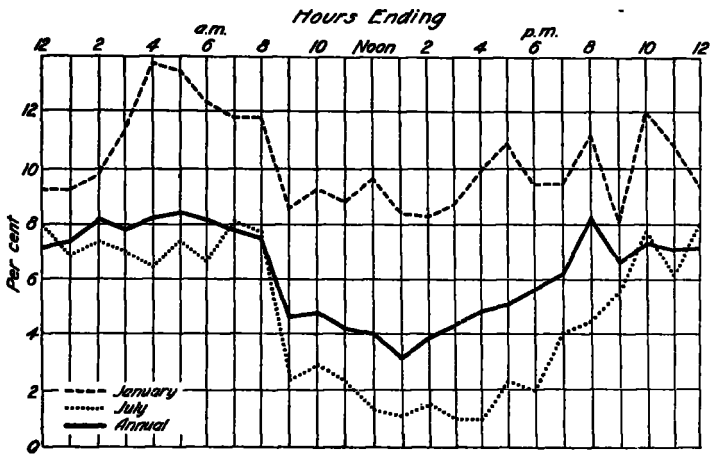

FIG. 1.—Average hourly frequency of rainfall for Honolulu, Hawaii, for the years 1905–1923, inclusive

at least, the monthly amounts being proportional to the frequency and intensity of those disturbances of the pressure distribution which result in temporary reversal of the northeast trades.

Honolulu is situated immediately in the lee of the Koolau Range, hence its rainfall is a combination of the two types, the most important being that of cyclonic origin. The rains induced by the trade winds come in brief, light showers through which the sun not infrequently shines; hence the common local expression "liquid sunshine." It is probable that the condition most favorable to the formation of these showers is a more than usual amount of low cumulus or stratocumulus clouds over the surrounding ocean areas, together with a moderate wind force.

It is a matter of common observation that these showers, wherever they occur in the islands, are of most frequent occurrence during the night and early morning hours, a fact fortunate in its economic aspect in that it provides the maximum time for work in the cane fields.

Figure 1 shows the frequency curve for the months of January and July and for the year at the Honolulu Weather Bureau office, and Table 1 the same for each month of the year. On the average the time of day in which rain is most frequent is from midnight to 8 a. m.; thereafter there is a sudden drop. The diurnal drop varies much from month to month both in regard to time of maximum frequency and to the range between highest and lowest frequency. The length of record is, of course, not sufficiently long to give a curve for each month which approaches the true normal, but it is plain enough that the daytime drop in frequency is most pronounced in summer, and it is highly probable that the time and degree of maximum in the true normal curve for each month varies considerably.

The month of greatest range of frequency, as shown in the table, is July, when rain falls eight times as often in the hour ending 7 a. m. as in the hours ending 3 and 4 o'clock in the afternoon. On the other hand, in January the hour of greatest frequency is less than twice as rainy as the hour of least frequency.

TABLE 1.—*Percentage of times 0.01 inch or more of rain has fallen during each hour for the years 1905 to 1923, inclusive, at Honolulu, Hawaii*

Month	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
January	9.3	9.8	11.4	13.8	13.6	12.6	11.9	11.9	8.7	9.3	9.0	9.7	8.5	8.3	8.8	10.0	10.9	9.5	9.5	11.2	8.1	11.9	11.0	9.3
February	8.0	8.0	6.7	6.5	6.1	6.1	5.0	5.8	3.7	4.5	3.4	3.9	4.5	5.2	4.3	5.6	5.6	6.3	4.5	7.6	6.3	7.1	7.5	7.8
March	7.5	8.0	10.4	9.0	11.0	8.7	9.2	10.4	7.0	6.3	4.6	4.8	3.7	5.8	6.8	7.5	6.8	7.1	8.8	10.4	8.5	7.0	7.1	7.3
April	8.2	10.2	7.0	7.9	8.6	9.3	7.2	5.4	4.6	5.8	5.3	4.2	2.3	2.1	3.7	4.7	5.4	5.8	6.1	8.9	4.9	4.0	6.7	7.9
May	5.8	5.8	6.5	7.3	6.8	6.0	6.2	6.8	3.4	2.1	2.4	1.9	2.2	2.5	2.9	2.7	3.4	3.8	4.2	5.6	4.0	4.4	4.2	5.4
June	4.7	6.0	6.1	7.7	6.0	7.7	6.7	5.4	2.1	3.2	2.8	2.1	1.8	2.3	2.1	3.6	2.8	3.2	4.2	4.4	4.2	4.7	4.9	5.2
July	7.0	7.3	7.1	6.3	7.5	6.6	8.1	7.8	2.5	3.0	2.4	1.4	1.2	1.5	1.0	1.0	2.4	2.0	4.1	4.6	5.6	7.8	6.1	8.0
August	7.1	6.6	7.1	6.8	5.6	6.6	6.8	7.0	3.2	2.5	1.9	2.2	1.5	1.7	2.1	3.4	3.9	3.2	3.8	7.5	7.0	7.0	7.6	6.6
September	6.5	8.9	7.2	7.2	7.7	7.4	7.6	6.5	3.6	4.2	3.6	3.7	2.8	2.6	3.0	3.9	3.2	4.6	6.8	9.2	6.3	6.5	4.7	5.6
October	6.8	7.3	5.8	7.0	7.3	7.8	7.1	7.0	4.2	3.1	3.2	2.5	1.7	2.4	4.9	4.2	4.2	6.1	5.4	7.8	5.9	7.3	6.6	5.3
November	9.2	10.0	9.6	8.6	10.0	8.2	9.3	8.1	5.8	4.9	4.6	4.9	4.4	5.1	5.4	5.2	5.8	7.4	8.2	12.1	9.2	9.6	8.6	9.2
December	8.7	9.0	9.5	10.5	11.0	11.0	10.2	9.7	7.1	8.8	6.8	6.6	6.8	7.5	9.2	7.6	7.8	9.3	10.5	11.9	9.9	10.0	9.9	8.7
Means	7.4	8.1	7.9	8.2	8.4	8.2	7.9	7.6	4.7	4.8	4.2	4.0	3.4	3.9	4.5	5.0	5.2	5.7	6.3	8.4	6.7	7.3	7.1	7.2

In Table 2 is shown the frequency of day and night rains, and in Table 3 are given the percentages of rain which fall during the night for each month and for the year. The heavy falls which may occur on any one day, especially during winter, give rise to a high monthly variability and causes the figures as given in percentage of total rainfall to depart greatly from what would be the true normal. Thus in January the low percentage of 48 for the rain which falls at night was brought about by several heavy rains which fell during the daytime. The same is true with the still lower percentage in June. Averaging up the percentages for the summer half year and the winter half year we find that 62 per cent of the rain frequency and 61 per cent of the total rainfall occurs at night in the former, while 56 per cent of the frequency and 58 per cent of the total rainfall occurs in the latter. It is highly probable, therefore, that the diurnal variation in total rainfall is practically the same as for frequency.

TABLE 2.—*Average number of times 0.01 inch, or more, of rain has fallen during the 12 hours ending with the 8 a. m. and 8 p. m. observations, for the years 1905 to 1923, inclusive, at Honolulu, Hawaii*

Month	8 a. m.	8 p. m.	Month	8 a. m.	8 p. m.
January	12	10	August	9	6
February	8	6	September	10	7
March	10	8	October	10	7
April	9	7	November	10	8
May	8	5	December	12	9
June	9	5			
July	11	4	Mean	10	7

TABLE 3.—*Percentage of rain falling during the nighttime (12 hours ending at 8 a. m.), for the years 1905 to 1923, inclusive, at Honolulu, Hawaii*

Month	Per cent	Month	Per cent
January	48	August	71
February	62	September	53
March	56	October	63
April	60	November	62
May	62	December	54
June	43		
July	78	Mean	59

The diurnal march of rainfall for Honolulu would normally be expected to follow the ocean type, the land masses being insufficient to induce any marked departure. It closely resembles that shown by Fassig [1] for San Juan, P. R., except for the absence of a small maximum during the early afternoon. The cause of the night maximum of cloudiness and rainfall is generally believed by meteorologists to be the result of a more rapid radiation aloft than at the ocean surface, thereby causing a convectional overturning of the air at this time. This being the case it would normally be expected that the diurnal variation would be the greatest at the equator, decreasing with increasing latitude in so far as this affects the intensity of insolation. The variation should also be greater in summer than in winter.

The unusual high night maximum in Honolulu during the summer time is probably caused by the more abundant formation of low clouds during the night hours, being just sufficient to form a shower over the city. It is worth remarking in this connection that the diurnal march of rainfall is generally opposite in this case to that of wind velocity, despite the fact that some wind is necessary to the formation of the trade wind shower.

A rather peculiar feature of the annual curve is the brief but marked secondary maximum between the hours of 7 and 8 o'clock in the evening. This secondary maximum can be observed in every month but July, and is very pronounced in the months of March, April, September, November, and December. In the last two months this secondary maximum is greater than the early morning one, though also briefer. It certainly is not synchronous with any known maximum of rainfall or cloudiness over the ocean.

[1] Cf. Fassig, O. L. Tropical rains—their duration, frequency, and intensity. Proc. Second Pan Amer. Scien. Cong.: 460-473.

THE GLAZE STORM OF DECEMBER 17-18, 1924, IN ILLINOIS [1]

551.578.4 (773)

By CLARENCE J. ROOT, Meteorologist

[Weather Bureau, Springfield, Ill., January, 1925]

A severe glaze storm occurred in west-central Illinois on December 17 and 18, the area of great destruction embracing a territory about 75 miles in width and 170 miles in length. During the entire period of the storm, warm and dry weather prevailed in the extreme southern portion of the State.

In the affected area trees were badly damaged, wires broken, and thousands of electric poles went down. Electric services were paralyzed, and it will require weeks to restore operation and months to permanently rebuild the lines. Some rural telephone systems were ruined. Fortunately, there was no wind; otherwise the destruction would have been much greater. The ground was covered with a crust of one or more inches of ice and sleet, and apprehension was felt for winter grains. The icy conditions, together with the cold weather that followed the storm, rendered difficult the work of restoration. There was no thawing until the 30th and none of consequence until January 3. The ice on the trees gradually decreased, but the ground conditions remained unchanged until the thaw.

The situation in Springfield was typical of the rest of the area. Sleet and freezing rain alternated, the total precipitation being 3.63 inches. Probably three-fourths of the trees in the city were injured to a greater or less extent, and in places the streets were a tangle of wires, poles, and brush. The ice on the upper side of objects ranged from 0.4 to 0.8 inch, and the weight of twigs was increased fifteen times. The depth of sleet and ice on the ground was 1.9 inches. It is probable that there was more ice in the storm of February, 1883, the weight of ice per foot of wire at that time being 11 ounces as compared with 8 ounces in the present storm. It must be remembered, however, that in 1883 there were very few wire services, so the money loss is far greater in the present storm.

The street railway company and the Illinois Traction System (electric) resumed complete operation 17 days after the storm. About one-half of the light and power customers had no electricity, and 3,000 telephones were out of commission. Electric light service was completely restored January 10. Springfield had no outside wire connection for several days. Without dispatching facilities and with frozen switches and frogs, the steam roads operated with great difficulty and trains were hours late. The ice had practically disappeared from the trees and wires by January 4, but at this writing, January 20, there is still considerable ice on the ground. The duration of ice on the trees is probably without precedent in this section.

The Western Union Telegraph Co. lost 8,000 poles and the Illinois Bell Telephone Co. about 23,000. The total damage to wire services in Illinois will probably equal or exceed $5,000,000. If there is added to this the loss of business, the damage to shade and orchard trees, and the possible injury to winter grains, the storm may be classed as one of the most disastrous of its kind in the history of the State.

[1] Condensed from the December number of Climatological Data, Illinois Section.